THE EFFECT OF THE MESO- AND MACROFAUNA ON THE HUMIFICATION OF THE LITTER IN A HORNBEAM-OAK MIXED FOREST

by

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A characteristic feature of the forest ecosystems of the temperate zone is that they shed their leaves at the end of summer or early in autumn, and in this way a considerable quantity of dead organic matter gets on to the soil of the forest. The litter layer produced in this way undergoes decomposition, which leads to the formation of the characteristic humus layer of the forest soils. This decomposition consist of rather complicated physical, chemical and biological processes in which the micro-organisms of the soil (Witkamp 1963, Howard – Howard 1974), as well as the soil fauna (Dudich – Balogh – Loksa 1953, Dunger 1958 a, 1958 b, Gere 1956, 1962 a, 1962 b, Zicsi-–Hargitai – Pobozsny 1971) have important functions. The activity of these organisms greatly depends on the quality of the kinds of litter and on their chemical state; at the same time these organisms themselves strongly affect the physical and chemical processes taking place in the litter.

It is generally accepted that it is the arthropods of the soil which disintegrate the litter, while the micro-organisms are responsible for its chemical transformation.

The aim of the present work was to compare the role of the soil fauna with that of the micro-organisms in the decomposition of the two dominant kinds of litter in a hornbeam-oak mixed forest stand *(Querco robori-Carpinetum)*. The first observations in this field were presented at the 7th Meeting of the Soil Biology Section of the Hungarian Society for Soil Science on Soil Biology and Convesvation of the Biosphere, Keszthely, 2–4/IX, 1975 (Csuták – Bayoumi 1975). At the above Meeting we have reported that first it is the macrofauna, and then the micro-organisms which are responsible for the disappearance of litter leaves, while the mesofauna plays a minor role in this process. In the present paper it will be shown to what extent the litter-inhabiting animals take part in the chemical transformation of litter leaves.

Material and Methods

Litter decomposition was studied in a hornbeam-oak mixed forest near the village Szendehely. Analyses of similar character have been in course since 1970 in that area. A detailed description of this forest was presented by I s é p y (1974).

5 gr each of the litters of both hornbeam and pedunculate oak were weighed into unglazed earthen pots, which were then covered with nylon nets of three different meshes. The smallest mesh was 175 microns: only the micro-organisms and the microfauna *(Protozoa, Nematoda)* could pass through it into the inside of the pots. In the next series the mesh size was 2–3 mm so that, besides the organisms mentioned above, also individuals of the mesofauna *(Collembola*, acari, etc.) could get in, while in the third series also representatives of the macrofauna *(Diplopoda, Isopoda, Enchytraeidae*, juvenil and small earthworms) could find their way into the pots. In this series the mesh size was 7 mm.

The pots were dug into the soil in a way that their openings were at the some level as the soil surface. Every second month three pots were taken from each of series of pots containing either kinds of litter and the animals were extracted from them in the laboratory. Then, upon due drying, the loss of weight of the litter was determined.

The data obtained were reported in the above mentioned lecture of the author.

Next, the following experiments were done concerning the humus quality of the litter leaves.

1. Determination of the total amount of humus (H%) was done by the combustion method. Dividing the values thus obtained by 1.724 yielded the C content of the samples.

2. Determination of total N content was carried out by Kjeldahl's method. From the above data the C:N ratio of the litter leaves was calculated.

3. Stability of the humus substances was determined by using the stability coefficient (K) as described by H a r g i t a i (1955):

$$K = \frac{Q}{H\%};$$

$$Q = \frac{E_{NaF}}{E_{NaOH}};$$

where E_{NaF} is the extinction of the humus substances soluble in NaF, E_{NaOH} is the extinction of humus substances soluble in NaOH, H% the total organic matter content and K the stability coefficient.

The more advanced the process of humification, the higher is the vahie of K.

The values of extintion were measured at 9 various wave-lengths in a Pulfrich photometer.

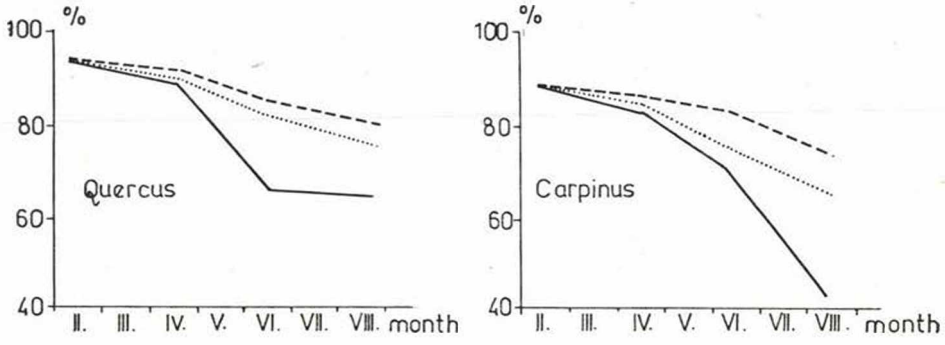
Results and Discussion

Table I. shows the values of H% for the two kinds of litter at different dates of sampling. It can be seen that, taking the initial value as 100%, in the case of hornbeam litter this value fell to a half (51,2%) between February and August. With the oak the decrease was only 31,1%.

Table I

Changes in organic matter content (H%) of the litter of Quercus robur and Carpinus betulus during the experiment

Date of sampling	Quercus robur			Carpinus betulus		
	Mesh of the nets covering the pots			Mesh of the nets covering the pots		
	175 microns	2 mm	7 mm	175 microns	2 mm	7 mm
13.2.	92.83	92.83	92.83	88.22	88.22	88.22
18.4.	90.41	90.09	88.41	84.73	83.61	82.44
5.6.	84.17	81.63	64.95	83.31	75.59	70.35
14.8.	79.26	74.97	63.95	73.39	64.90	42.80



1. Changes in organic matter content (H%) of the litter of *Quercus robur* and *Carpinus betulus* during the experiment.
Mesh of the nylon nets covering the earthen pots – – – – 175 μ, ... 2mm, ——— 7 mm

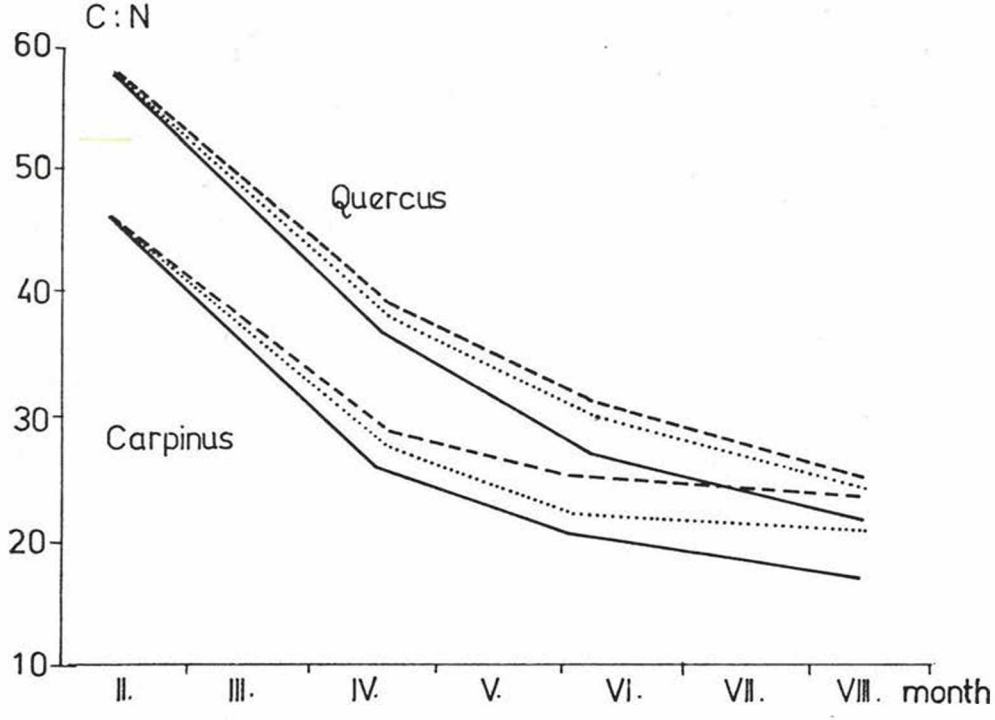
A similarly decreasing tendency is shown by the ratio C:N during the experiment. The maximum decrease was 61,5% with the hornbeam and 55,6% with the oak (Table II.)

Table II

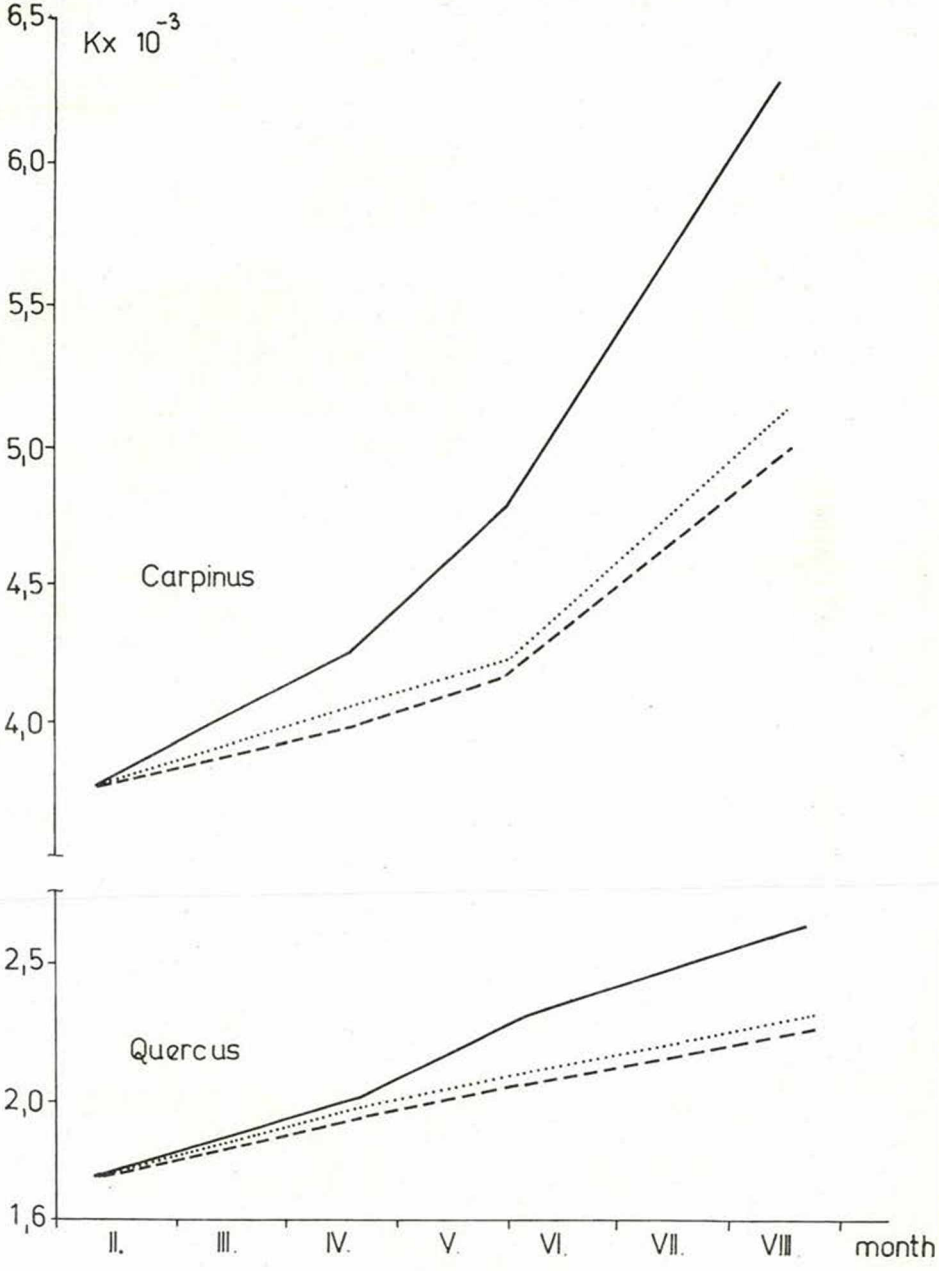
Changes in the ratio C:N calculated for the litter of Quercus robur and Carpinus betulus during the experiment

Date of sampling	Quercus robur			Carpinus betulus		
	Mesh of the nets covering the pots			Mesh of the nets covering the pots		
	175 microns	2 mm	7 mm	175 microns	2 mm	7 mm
13.2.	57.4	57.4	57.4	46.2	46.2	46.2
18.4.	37.2	38.5	39.6	29.1	27.9	25.9
5.6.	27.7	30.4	31.6	25.9	22.8	20.5
14.8.	22.8	24.5	25.5	24.1	21.6	17.8

The values of the stability coefficients calculated for the humus qualification in the litter leaves (Table III) indicate that, in the course of the experiment, the humus quality of the litter leaves has improved. With the hornbeam this was much more marked than with the oak. It should be noted that alredy at the initial stage the hornbeam had a much higher stability coefficient than the oak.



2. Changes in the ratio C:N calculated for the litter of *Quercus robur* and *Carpinus betulus* during the experiment.



3. Changes in the stability coefficient calculated for the humus from the litter of *Carpinus betulus* and *Quercus robur* during the experiment

Table III

Changes in the stability coefficient calculated for the humus from the litter of Carpinus betulus and Quercus robur during the experiment

Date of sampling	Quercus robur			Carpinus betulus		
	Mesh of the nets covering the pots			Mesh of the nets covering the pots		
	175 microns	2 mm	7 mm	175 microns	2 mm	7 mm
13.2.	1.74	1.74	1.74	3.74	3.74	3.74
18.4.	1.96	2.00	2.03	3.96	4.06	4.23
5.6.	2.08	2.12	2.34	4.14	4.20	4.77
14.8.	2.28	2.33	2.66	4.96	5.11	6.29

These changes were biggest with the pots into which also the soil fauna could enter besides the micro-organisms.

The role to be ascribed to the mesofauna in the chemical transformation of the litter is quite insignificant. This is in keeping with the fact that the part it had in litter consumption was similarly rather small.

It is clear from the graph the effect of the macrofauna is much more marked. This is especially apparent in the Figures indicating the changes in the values of H% and K.

Summary

In the paper an attempt was made to elucidate the role of the soil fauna in the chemical transformation of litter leaves. It is well known that, when passing the alimentary canal of the soil inhabiting organisms, the litter does not undergo a significant chemical transformation (D u n g e r 1958 a), yet these animals also have some function in the chemical transformation of the litter besides cutting it up. One might compare this function to the effect of catalyzers: namely, by increasing the surface of the litter leaves while breaking them into small pieces they render the litter fragments more accessible to the microorganisms, which in turn, can exert their activity with a higher efficiency.

G e r e and H a r g i t a i (1971) demonstrated that on the granules of the excrement of the macrofauna the humus formation processe took place more rapidly. This accelerating effect of the macrofauna appears, however, not only in the excrement but also in the litter leaves which it has attacked previously.

Such a catalyzing function is much less marked in the case of the mesofauna than that of the macrofauna. This can be explained by the fact that the majority of these animals feed on mycelia or on excrements of larger organisms (C s u t á k 1975) and attack only the litter leaves wich are already fully exposed.

If we compare the decomposition of hornbeam leaves with that of oak leaves, it can be seen that in the hornbeam the processes of decompo-

sition take place rapidly than in the oak. Even in the initial stage, when the litter is shed, the leaves of the former are of better quality than those of the latter, and this also contributes to a sooner and create more intensive beginning of their decomposition.

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